U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

9.1.1 NEW FUEL STORAGE

REVIEW RESPONSIBILITIES

Primary - ~~Auxiliary~~Plant Systems Branch (~~ASB~~SPLB)[1]

Secondary - ~~None~~Civil Engineering and Geosciences Branch (ECGB)[2]
Reactor Systems Branch (SRXB)[3]

I. AREAS OF REVIEW

Nuclear reactor plants include storage facilities for the storage of new fuel. The quantity of new fuel to be stored varies from plant to plant, depending upon the specific design of the plant and the individual refueling requirements. The ~~ASB~~SPLB[4] verifies that the storage facility maintains the new fuel in a subcritical array during all credible storage conditions in accordance with General Design Criteria 2, 5, 61, and 62. The ~~ASB~~SPLB[5] reviews the new fuel storage facility design including the fuel assembly storage racks and storage vault with respect to the following:

1. The quantity of fuel to be stored.

2. The design and arrangement of the storage racks for maintaining a subcritical array during all storage conditions.

3. The degree of subcriticality, and the supporting analysis and associated assumptions.

4. The effects of external loads and forces on the new fuel storage racks and vault (e.g., safe shutdown earthquake, crane uplift forces).

5. The effects of sharing in multi-unit complexes, and failures of other plant equipment close to the new storage facility.

Review Interfaces[6]

1. ~~ASB~~SPLB[7] also performs the following reviews under the Standard Review Plan (SRP),[8] sections indicated.

   ~~(a)~~a.[9] Review of flood protection is performed under SRP Section 3.4.1,

   ~~(~~b.~~)~~ Review of the protection against internally generated missiles is performed under SRP Section 3.5.1.1,

   ~~(~~c.~~)~~ Review of structures, systems, and components to be protected against externally generated missiles is performed under SRP Section 3.5.2, and

   ~~(~~d.~~)~~ Review of high and moderate energy pipe breaks as performed under SRP Section 3.6.1.

   e. Review of equipment qualification is performed under SRP Section 3.11.[10]

   f. Review of fire protection is performed under SRP Section 9.5.1.[11]

~~Should the design deviate significantly from previously accepted designs, ASB will request for a review by the Core Performance Branch (CPB) to verify the K(eff) of the loaded storage racks is acceptable.~~[12]

2. In addition, ~~ASB~~SPLB[13] will coordinate other branches evaluations that interface with the overall review of the system as follows:

   a. The ~~Structural Engineering Branch (SEB)~~Civil Engineering and Geosciences Branch (ECGB)[14] determines the acceptability of the design analyses, procedures, and criteria used to establish the ability of seismic Category I structures housing the system and supporting systems to withstand the effects of natural phenomena such as the safe shutdown earthquake (SSE), the probable maximum flood (PMF), and tornadoes and tornado missiles as part of its primary review responsibility for SRP Sections 3.3.1, 3.3.2, 3.5.3, 3.7.1, through 3.7.4, 3.8.4, and 3.8.5.

   b. The Mechanical Engineering Branch (~~MEB~~EMEB)[15] determines that the components and structures are designed in accordance with applicable codes and standards as part of its primary review responsibility for SRP Sections 3.9.1 through 3.9.3.

   c. The ~~MEB~~EMEB[16] also determines the acceptability of the seismic and quality group classifications for system components as part of their primary review responsibility for SRP Sections 3.2.1 and 3.2.2.

d. The ~~Radiological Assessment Branch (RAB)~~Emergency Preparedness and Radiation Protection Branch (PERB)[17] reviews the adequacy of the radiation monitoring system as part of its primary review responsibility for SRP Section 12.3-12.4.

~~The Equipment Qualification Branch (EQB) reviews the adequacy of the equipment qualification as part of their review responsibility for SRP Section 3.11.~~[18]

e. The Materials and Chemical[19] Engineering Branch (~~MTEB~~EMCB) ~~verifies that inservice inspection requirements are met for system components as part of its primary review responsibility for SRP Section 6.6 and~~[20], upon request, verifies the compatibility of the materials of construction with services conditions.

f. The ~~Materials Engineering Branch (MTEB)~~ECGB verifies that inservice inspection requirements are met for system components as part of its primary review responsibility for SRP Section 6.6 ~~and, upon request, verifies the compatibility of the materials of construction with services conditions~~.[21]

~~The review for Fire Protection, Technical Specifications, and Quality Assurance are coordinated and performed by the Chemical Engineering Branch, Licensing Guidance Branch and Quality Assurance Branch as part of their primary review responsibility for SRP Sections 9.5.1, 16.0, and 17.0, respectively.~~[22]

g. The Technical Specifications Branch (TSB) coordinates and performs reviews of the proposed technical specifications as part of its primary review responsibility for SRP Section 16.0.[23]

h. The Quality Assurance and Maintenance Branch (HQMB) coordinates and performs reviews of quality assurance programs as part of its primary review responsibility for SRP Chapter 17.[24]

i. Should the design deviate significantly from previously accepted designs, SPLB will request a review by the Reactor Systems Branch (SRXB) to verify that the K(eff) of the loaded storage racks is acceptable as part of its secondary review responsibility under this SRP section.[25]

For those areas of review identified above as being the responsibility of other branches, the acceptance criteria and ~~their~~ methods of application are contained in the referenced SRP sections ~~corresponding to those branches~~.[26]

II. ACCEPTANCE CRITERIA

Acceptability of the new fuel storage facility design as described in the applicant's analysis report (SAR) is based on specific general design criteria, regulatory guides, industry standards, and on independent calculations and staff judgments with respect to facility functions and

component selection. The design of the new fuel storage facility is acceptable if the integrated design is in accordance with the following criteria:

1. General Design Criterion 2 (GDC 2),[27] as it relates to the ability of structures housing the facility and the facility components to withstand the effects of earthquakes. Acceptance is based on meeting the guidance of Regulatory Guide 1.29, position C.1.~~1~~l,[28] as it relates to seismic classification of facility components.

2. General Design Criterion 5 (GDC 5),[29] as it relates to shared structures, systems and components important to safety being capable of performing required safety functions.

3. General Design Criterion 61 (GDC 61),[30] as it relates to the facility design for fuel storage.

4. General Design Criterion 62 (GDC 62),[31] as it relates to the prevention of criticality by physical systems or processes utilizing geometrically safe configurations.

Specific criteria necessary to meet the requirements of General Design Criteria 61 and 62 are ANS 57.1,[32] "Design Requirements for LWR Fuel Handling Systems," and ANS 57.3,[33] "Design Requirements for New LWR Fuel Storage Facilities" (proposed), as they relate to the prevention of criticality and to the aspects of the radiological design.

Technical Rationale[34]

The technical rationale for application of these acceptance criteria to reviewing new fuel storage is discussed in the following paragraphs:[35]

1. Compliance with GDC 2 requires that nuclear power plant structures, systems, and components important to safety be designed to withstand the effects of natural phenomena such as earthquake, tornado, hurricane, flood, tsunami, and seiche without loss of capability to perform their safety functions.

   The function of the new fuel storage facility is to maintain new fuel in a subcritical array during all credible storage conditions. The requirements of GDC 2 are imposed to verify that the new fuel storage facility is designed to withstand the effects of earthquakes, thereby ensuring that the new fuel will be maintained in a subcritical array. Position C.1.l of Regulatory Guide 1.29 provides guidance acceptable to the staff for meeting these requirements.

   Meeting the requirements of GDC 2 provides assurance that new fuel will remain in a subcritical array during natural phenomena events.[36]

2. Compliance with GDC 5 requires that structures, systems, and components important to safety shall not be shared among nuclear power units unless it can be shown that such sharing will not significantly impair their ability to perform their safety functions, including, in the event of an accident in one unit, an orderly shutdown and cooldown of the remaining units.

The requirements of GDC 5 apply to this section because the reviewer determines whether the structures, systems, and components for new fuel storage facilities at multiple-unit sites are shared among the units. The reviewer then verifies that structures, systems, or components that are shared are designed in such a manner that an accident at one facility will not significantly impair the ability of the remaining facility to maintain the new fuel in a subcritical array.

Meeting the requirements of GDC 5 provides assurance that a failure in one unit will not affect other units of a multiple-unit site.[37]

3. Compliance with GDC 61 requires that fuel storage and handling, radioactive waste, and other systems that may contain radioactive materials be designed to ensure adequate safety under normal and postulated accident conditions.

GDC 61 applies to this SRP section because the reviewer evaluates inspection and testing of components, shielding for radiation protection, containment and filtering, testability of residual heat removal, and preventing a significant reduction of fuel storage coolant inventory under accident conditions. ANS 57.1 and ANS 57.3 (proposed) provide guidance acceptable to the staff for meeting the requirements of this criterion.

Meeting the requirements of GDC 61 provides assurance that criticality and releases of radioactive materials related to the storage and handling of new fuel will be prevented.[38]

4. Compliance with GDC 62 requires that criticality in the fuel storage and handling system be prevented through the use of physical systems or processes, with preference being given to the application of geometrically safe configurations.

The function of the new fuel storage facility is to maintain new fuel in a subcritical array during all credible storage conditions. This role requires that designs for new fuel storage provide assurance that spacing is adequate to prevent criticality during earthquakes or other natural phenomena, as well as and to prevent flooding with potential moderators. The configuration of new fuel storage must also prevent the insertion of potential moderators into existing spaces. ANS 57.1 and ANS 57.3 (proposed) provide guidance acceptable to the staff for meeting the requirements of this criterion.

Meeting the requirements of GDC 62 provides assurance that criticality will be prevented in the new fuel storage facility.[39]

III. REVIEW PROCEDURES

The procedures below are used during the construction permit (CP) application review to determine that the applicant's design criteria and bases and the preliminary design meet the acceptance criteria given in subsection II of this SRP section. For operating license (OL) applications, the review procedures and acceptance criteria are utilized to verify that the initial design criteria and bases have been appropriately implemented in the final design as set forth in the final safety analysis report. The review procedures given are for a typical storage system. Any variance of the review, to adjust to a proposed unique design, is such as to ~~assure~~ensure[40]

that the facility design conforms to the criteria in subsection II of this SRP section. The reviewer selects and emphasizes material from this SRP section as may be appropriate for a particular case.

On those occasions were the design deviates significantly from previously approved designs ~~ASB~~SPLB[41] will request the coordinating review branches to provide input for the areas of review stated in subsection I of this SRP section. The ~~ASB~~SPLB[42] will incorporate such input as required to ~~assure~~ensure[43] that this review procedure is complete.

1. The quantity of new fuel to be stored onsite forms the basis for the design capacity of the vault and the number of storage racks provided. The SAR is reviewed to determine that the facility description includes the storage capacity provided by the design. The SARs for recent light-water reactor applications have stated that the storage space provided is consistent with the number of new fuel assemblies used during the refueling cycle. ~~In general,~~Usually,[44] storage capacity for approximately one-third of a core is ~~usually~~ provided for each unit of a plant (e.g., 1/3 core for single unit design and 2/3 core for a dual unit design).

2. The information provided in the SAR pertaining to criticality safety of the new fuel storage facility is evaluated by ~~CPB~~SRXB[45] upon request. The facility design criteria, safety evaluation, system description, and the layout drawings for the storage vault and racks are reviewed to verify that:

    a. Criticality information (including the associated assumptions and input parameters) in the SAR must show that the spacing between fuel assemblies in the storage racks is sufficient to maintain the array, when fully loaded and flooded with potential moderators ~~such as nonborated water fire extinguishant aerosols,~~ (e.g., high-pressure water spray)[46] in a subcritical condition, i.e., K(eff) of less than about 0.95. Furthermore, the design of the new fuel storage racks will be such that the K(eff) will not exceed 0.98 with fuel of the highest anticipated reactivity in place assuming optimum moderation. Credit may be taken for neutron absorbing materials.

    b. The design is such that a fuel assembly cannot be inserted anywhere in the racks other than in the design locations and provisions have been made for drainage of the vault ~~design,~~[47] to prevent the accumulation of a fluid moderator.

    c. Failures of nonsafety-related systems or structures not designed to seismic Category I criteria that are located in the vicinity of the new fuel storage facility are reviewed to ~~assure~~ensure[48] that they will not cause an increase in K(eff) beyond the maximum allowable. The SAR description section, the general arrangement and layout drawings, and the tabulation of seismic design classifications for structures and systems are reviewed and evaluated to ~~assure~~ensure[49] that this condition is met. A statement in the SAR establishing the above condition as a design criterion is acceptable at the CP review stage.

    d. Design calculations should show that the storage racks and the anchorages can withstand the maximum uplift forces available from the lifting devices without an

increase in K(eff). A statement in the SAR that excessive forces cannot be applied due to the design of the lifting devices is acceptable if justification is presented. The evaluation procedures identified in SRP Section 9.1.4 are used to validate this statement.

e. The vault and racks have been designed to preclude damage from dropped heavy objects.

f. Sharing of a storage facility in multi-unit plants does not result in any added potential for increasing the K(eff) of the storage array.

3. The reviewer verifies that the safety function of the facility will be maintained, as required, if the facility is subjected to natural phenomena such as earthquakes, tornadoes, hurricanes, and floods. In making this determination, the reviewer considers the following points:

a. The facility design basis and criteria, and the component classification tables presented in the SAR are reviewed to verify that the new fuel storage facility, including storage vault and racks, have been classified and will be designed to seismic Category I requirements.

b. The essential portions of the new fuel racks and storage vault are reviewed to verify that protection from the effects of floods, hurricanes, tornadoes, and internally or externally generated missiles is provided. Flood protection and missile protection criteria are discussed in sections of the SRP contained in Chapter 3. The reviewer utilizes the procedures of those SRP sections, as appropriate, to ~~assure~~ensure[50] that the analyses presented are valid. A statement to the effect that the storage will be located in a seismic Category I structure that is designed to withstand the effects of internally and externally generated missiles and floods is an acceptable commitment at the CP stage. The review for seismic design is performed by ~~SEB~~ECGB[51] and the review for seismic and quality group classification is performed by ~~MEB~~EMEB[52] as indicated in subsection I of this SRP section.

For standard design certification reviews under 10 CFR Part 52, the procedures above should be followed, as modified by the procedures in SRP Section 14.3 (proposed), to verify that the design set forth in the standard safety analysis report, including inspections, tests, analysis, and acceptance criteria (ITAAC), site interface requirements and combined license action items, meet the acceptance criteria given in subsection II. SRP Section 14.3 (proposed) contains procedures for the review of certified design material (CDM) for the standard design, including the site parameters, interface criteria, and ITAAC.[53]

IV. EVALUATION FINDINGS

The reviewer verifies that the information provided supports conclusions of the following type to be included in the staff's safety evaluation report (SER):[54]

The new fuel storage facility includes the fuel assembly storage racks, the concrete storage vault that contains the storage racks, and auxiliary components. Based on the review of the applicant's proposed design criteria, design bases, and safety classification for the new fuel storage facility regarding the provisions necessary to maintain a subcritical array.

The staff concludes that the design of the new fuel storage facility and supporting systems is acceptable and meets the requirements of General Design Criteria 2, 5, 61, and 62 with respect to the measures taken to provide protection against the effects of natural phenomena, missiles, environmental conditions, and the sharing of structures, systems, and components. This conclusion is based on the following:

1. The natural phenomena requirements of General Design Criterion 2 regarding earthquakes have been met since it conforms to position C.1.l of Regulatory Guide 1.29.

2. The shared portions of the new fuel storage facility between nuclear power units meet the requirements of General Design Criterion 5 in that it was demonstrated that such sharing did not impair, under accident conditions, the shared structures, systems, and components ability to perform ~~this~~their[55] safety functions.

3. The fuel storage and handling and radioactivity control aspects of General Design Criterion 61 and the criticality aspects of General Design Criterion 62 have been met based on the new fuel storage system meeting ANS 57.1, and ANS 57.3, as they relate to the prevention of criticality and radiological releases.

For design certification reviews, the findings will also summarize, to the extent that the review is not discussed in other safety evaluation report sections, the staff's evaluation of inspections, tests, analyses, and acceptance criteria (ITAAC), including design acceptance criteria (DAC), site interface requirements, and combined license action items that are relevant to this SRP section.[56]

V. IMPLEMENTATION

The following is intended to provide guidance to applicants and licensees regarding the NRC staff's plans for using this SRP section.

This SRP section will be used by the staff when performing safety evaluations of license applications submitted by applicants pursuant to 10 CFR 50 or 10 CFR 52.[57] Except in those cases in which the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described herein will be used by the staff in its evaluation of conformance with Commission regulations.

The provisions of this SRP section apply to reviews of applications docketed six months or more after the date of issuance of this SRP section.[58]

Implementation schedules for conformance to parts of the method discussed herein are contained in the referenced Regulatory Guides.

VI. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."

2. 10 CFR Part 50, Appendix A, General Design Criterion 5, "Sharing of Structures, Systems, and Components."

3. 10 CFR Part 50, Appendix A, General Design Criterion 61, "Fuel Storage and Handling and Radioactivity Control."

4. 10 CFR Part 50, Appendix A, General Design Criterion 62, "Prevention of Criticality in Fuel Storage and Handling."

5. Regulatory Guide 1.29, "Seismic Design Classification."

6. ANS 57.1-1980,[59] "Design Requirements for Light-Water Reactor Fuel Handling Systems."

7. ANS 57.3-1981,[60] "Design Requirements for New LWR Fuel Storage Facilities" (proposed).

[This Page Intentionally Left Blank]

SRP Draft Section 9.1.1

Attachment A - Proposed Changes in Order of Occurrence

Item numbers in the following table correspond to superscript numbers in the redline/strikeout copy of the draft SRP section.

Item	Source	Description
1.	Current PRB name and abbreviation	Changed PRB to Plant Systems Branch (SPLB).
2.	Current ECGB review responsibility	Added SRB responsibility for SRP Section 9.1.1.
3.	Current SRXB review responsibility	Added SRB responsibility for SRP Section 9.1.1.
4.	Current PRB abbreviation	Changed PRB to SPLB.
5.	Current PRB abbreviation	Changed PRB to SPLB.
6.	SRP-UDP format item	Added "Review Interfaces" to AREAS OF REVIEW and organized in numbered paragraph form to describe how SPLB reviews aspects of the new fuel storage facility design under other SRP sections and how branches support the review.
7.	Current PRB abbreviation	Changed PRB to SPLB.
8.	Editorial	Defined "SRP" as "Standard Review Plan."
9.	Editorial	Removed parentheses from the letters.
10.	Current SPLB review responsibility	Added review responsibility under SRP Section 3.11.
11.	Current SPLB review responsibility	Added review responsibility under SRP Section 9.5.1.
12.	SRP-UDP format item	Removed section to reflect current SRP format.
13.	Current PRB abbreviation	Changed PRB to SPLB.
14.	Current secondary review branch name and abbreviation	Changed to reflect current name and responsibility for SRP Sections 3.3.1, 3.3.2, 3.5.3, 3.7.1, through 3.7.4, 3.8.4, and 3.8.5.
15.	Current SRB abbreviation	Changed to reflect current SRP name (EMEB) and responsibility for SRP Sections 3.9.1 through 3.9.3.
16.	Current SRB abbreviation	Changed to reflect current SRP name (EMEB) and responsibility for SRP Sections 3.2.1 and 3.2.2.
17.	Current PRB name and abbreviation	Changed to reflect current PRB name (PERB) and responsibility for SRP Section 12.3-12.4.
18.	Current PRB review responsibility	SPLB has assumed review responsibility for SRP Section 3.11. This interface was moved above.
19.	Current PRB name and abbreviation	Changed to reflect current PRB name (EMCB) and responsibility for SRP Section 6.6.
20.	Current PRB names and responsibilities	The review responsibility for SRP Section 6.6 has been reassigned to the ECGB. The interface with the EMCB is revised to reflect this change.

Item	Source	Description
21.	Current PRB names and responsibilities	The review responsibility for SRP Section 6.6 has been reassigned to the ECGB. This interface was separated from the existing interface with the EMCB.
22.	SRP-UDP format item	Removed section to reflect current SRP format.
23.	SRP-UDP format item	Revised section to reflect current SRP format.
24.	SRP-UDP format item	Revised section to reflect current SRP format.
25.	SRP-UDP format item	Revised section to reflect current SRP format.
26.	Editorial	Simplified for clarity.
27.	Editorial	Introduced "GDC 2" as initialism for "General Design Criterion 2."
28.	Regulatory Guide 1.29	Changed from C.1.1 to C.1.l to agree with the subsection designation in Regulatory Guide 1.29.
29.	Editorial	Introduced "GDC 5" as initialism for "General Design Criterion 5."
30.	Editorial	Introduced "GDC 61" as initialism for "General Design Criterion 61."
31.	Editorial	Introduced "GDC 62" as initialism for "General Design Criterion 62."
32.	Integrated Impact Number 397	ANS 57.1 was revised in 1992 to ANSI/ANS-57.1-1992. This reference should be updated to ANSI/ANS-57.1-1992 if a detailed comparison of the two versions supports the adoption of the more recent standard.
33.	Integrated Impact Number 397	Proposed ANS 57.3 was published in 1983 as ANSI/ANS-57.3-1983. This reference should be updated to ANSI/ANS-57.3-1983 if a detailed comparison of the two versions supports the adoption of the more recent standard.
34.	SRP-UDP format item, develop technical rationale	Added "Technical Rationale" to ACCEPTANCE CRITERIA and organized in numbered paragraph form to describe the basis for referencing the General Design Criteria.
35.	SRP-UDP format item, develop technical rationale	Added lead-in sentence for "Technical Rationale."
36.	SRP-UDP format item, develop technical rationale	Added technical rationale for GDC 2.
37.	SRP-UDP format item, develop technical rationale	Added technical rationale for GDC 5.
38.	SRP-UDP format item, develop technical rationale	Added technical rationale for GDC 61.

Item	Source	Description
39.	SRP-UDP format item, develop technical rationale	Added technical rationale for GDC 62.
40.	Editorial	Changed "assure" to "ensure."
41.	Current PRB abbreviation	Changed PRB to SPLB.
42.	Current PRB abbreviation	Changed PRB to SPLB.
43.	Editorial	Changed "assure" to "ensure."
44.	Editorial	Revised to eliminate redundancy.
45.	Current PRB abbreviation	Changed PRB to SRXB.
46.	Editorial	Substituted "(e.g., high-pressure water spray)" for "such as nonborated water fire extinguishant aerosols" to exemplify and promote the increased use of simplified linguistic expression in technical documents.
47.	Editorial	Deleted "design." "Drainage of the vault design" did not make sense.
48.	Editorial	Changed "assure" to "ensure."
49.	Editorial	Changed "assure" to "ensure."
50.	Editorial	Changed "assure" to "ensure."
51.	Current SRB abbreviation	Changed SRP to ECGB and specified responsibility for seismic design as indicated in subsection I of this SRP section.
52.	Current SRB abbreviation	Changed SRP to EMEB and specified responsibility for seismic and quality group classification of subsection I of this SRP section.
53.	SRP-UDP Guidance, Implementation of 10 CFR 52	Added standard paragraph to address application of Review Procedures in design certification reviews.
54.	Editorial	Provided "SER" as initialism for "safety evaluation report."
55.	Editorial	Modified for clarity.
56.	SRP-UDP Format Item, Implement 10 CFR 52 Related Changes	To address design certification reviews a new paragraph was added to the end of the Evaluation Findings. This paragraph addresses design certification specific items including ITAAC, DAC, site interface requirements, and combined license action items.
57.	SRP-UDP Guidance, Implementation of 10 CFR 52	Added standard sentence to address application of the SRP section to reviews of applications filed under 10 CFR Part 52, as well as Part 50.

Item	Source	Description
58.	SRP-UDP Guidance	Added standard paragraph to indicate applicability of this section to reviews of future applications.
59.	**Integrated Impact 1499**	Added the applicable version date to the reference for ANS 57.1.
60.	**Integrated Impact 1500**	Added the applicable version date to the reference for ANS 57.3.

SRP Draft Section 9.1.1

Attachment B - Cross Reference of Integrated Impacts

Integrated Impact No.	Issue	SRP Subsections Affected
397	Incorporates latest version of ANSI/ANS 57.1 and ANSI/ANS 57.3.	This is a placeholder integrated impact.
1499	Update the citation of ANS 57.1 to cite the 1980 version.	REFERENCES
1500	Update the citation of ANS 57.3 to cite the 1981 draft version.	REFERENCES